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Treatment Of Black Cotton Soil To Increased It's Stability And Bearing Capacity Using Cement Slurry

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Abstract - *Black cotton soils are good for agriculture but it has low bearing capacity than other soils and prefer for the construction of high-story buildings and highways. The black cotton soil has high swelling properties in the rainy season and has high shrinkage in the property in the summer season. Soil stabilization is having different methods and material that improves physical soil characteristics such as an increased bearing capacity of soil and increased shear resistance can be done by adding waster material, jute fiber, fly ash, lime, cement, and adding different admixture for compacting for the subgrade stabilization of the building, high storage, heavy bridges, railway track, and highway*

Hence in this paper, we conducted soil stabilization using cement, lime, and sand on black cotton soil for the improvement in the properties of black cotton soil as stability, reduced in reduced shrinkage by using cement slurry, sand, and lime in varying percentages. (Soil + 10% Sand +5% Lime + 5% Cement, Soil + 15% Sand +5% Lime + 5% Cement, Soil + 20% Sand +5% Lime + 5% Cement) Laboratory tests were undertaken to study the strength characteristics of back cotton soil with cement, sand, and lime.

Key Words: **Black cotton soil, Stabilization, Cement slurry, increasing stability**.

1. INTRODUCTION

Black cotton soil covers 20% of India's land area, mostly in Gujarat, Maharashtra, M.P., South U.P., and portions of Karnataka, A.P., and Tamilnadu. Soils have high consolidation settling and are particularly compressive when they are saturated. The high swelling characteristic of these soils causes harm to the structure. Black cotton soil loses a lot of its bearing ability during the rainy season as a result of water filling up the cracks and crevices. This soil contracts during the dry season, causing uneven building settlement, cracks in walls and floors, etc.

Enhancing the strength or carrying capacity of soil through controlled compaction, proportioning, and/or the addition of the appropriate admixtures or stabilisers is known as soil stabilisation. In order to boost strength and durability under design usage conditions and to extend the design life of the engineering project, soil, a naturally occurring substance, is stabilised. The characteristics of the soil will vary depending on its location, physical characteristics, and other factors. Several ways are available to stabilise the soil, but they should first be tested in a lab setting with actual soil before being used in actual field settings.

Image no 1 black cotton soil in India

It is necessary to improve the desirable properties of those soils because the fundamental property of the soil should have sufficient strength & load bearing capacity so that external loads may be passed to the lower layers effectively without experiencing any structural failure.

The long-term physical and chemical change of soil will improve its physical properties, which can improve shear and unconfined compressive strength and permanently lower the soil's permeability to water. Soil stabilisation should be cost-effective.

2. LITERATURE REVIEW

I. **Likhitha. H, Raghavendra.H. N, Rakesh. K.P (2018):** The laboratory test was conducted on black cotton soil where the stabilizer used where cement, and M-sand at varying percentages, Here the basic test was conducted like specific gravity, water content, liquid limit, plastic limit, optimum moisture content, and maximum dry density they conclude that engineering properties of soil can be increased by making use of stabilization.

II. **Badal Bankar, Dr. Satish Patil, Rajshekhar Ratho (2021):** In this paper behavior of soft soil was studied by stabilizing it with geogrid as a reinforcement element and various proportions (0%, 2%, 4%, 6%, & 8%) of cement. This shows the increase in the stability and bearing capacity of the subgrade soil at different proportions. In proportion to (BC soil+ Geogrid+6% cement) the CBR test was highest at 18.24 and at (BC+Geogrid+8%cement) the CBR value decreased to 17.59.

III. **V. Ramesh Babu, V. Ramesh Babu, Dr. B. Ramesh Babu (2016):** The present work is done in stabilizing the black cotton soil by using cement and sand. In this work tests conducted were plastic limit, liquid limits, specific gravity, standard proctor test, unconfined compression test, and California bearing ratio for the proportion of sand was taken 10%, 20% 30%, 40 and cement was taken 2% of black cotton soil.

IV. **Puneeth A, Ajay Nagaraj*, Aravind Sagar B(2021): Puneeth A, Ajay Nagaraj*, Aravind Sagar B(2021):** The ground granulated blast furnace slag and the cement were used in this work for the laboratory test was carried out for the different proportion combinations of black cotton soil and binders . And in this paper show an increase in the bearing capacity of soil

2. OBJECTIVE

- Conducting the detailed laboratory tests to find the properties of soil
- Increasing stabilization of the soil by adding cement, sand, and lime

3. MATERIAL

I. Cement: - We used 5% Portland pozzolanic cement (250 gm) of 5 kg of black cotton soil for the experiment. The addition of cement to soil, which acts as a binding agent and produces a weak form of concrete called soil cement. The amount of cement to be required is depends upon the type of the soil. The cement is can be used for the most types of soil

II. M Sand: - We used 10%, 15%, and 20% manufactured sand of 5 kg of black cotton soil. M-sand is manufacture artificial by crushing hard stones into small. We have taken the size of manufactured sand (M-sand) as less than 4.75 Sand used for the work is clean and coarse sand passing through a 4.75 mm sieve was oven dried for 24 hr. and cooled down

III. Lime: - We used 5 % Lime of 5 kg of black cotton soil the lime provides high water retention that allows for maximum early curing of the cementitious materials. We used Fine lime for this experiment the oven dry for 24 hrs. and cooled down the lime.

4. EXPERIMENTAL PROCEDURE

The primary properties of black cotton soil are determined. Then the soil is then stabilized with sand, cement, and lime. The amount of sand for stabilization is taken in the different proportions of 10%, 15%, and 20% by dry weight of soil, and the amount of cement and lime was taken as 5% respectively by dry weight of soil. Using these proportions, mix samples were prepared as given below and a set of laboratory tests were performed specific gravity, liquid limit, plastic limit, and moisture content. The CBR and modified proctor test values of both natural soil and mixed proportion samples.

1) Black Cotton Soil (5kg)
2) Soil + 10% Sand +5% Lime + 5% Cement
3) Soil + 15% Sand +5% Lime + 5% Cement
4) Soil + 20% Sand +5% Lime + 5% Cement

4.1 Modified Proctor Test:

The 3 kg of black cotton soil was taken. Then the sample passed by 4.75 mm sieved then dried in an oven for 24 hours. After this, the sample was left to cool down at room temperature for 30 minutes and then filled in three layers into a standard mold. Each layer was compacted by a hammer with 25 blows, and after compaction, the collar was detached, and the extra soil was removed from the top of the mold. The total weight of wet soil with the mold is measured. A representative portion of the soil in the mold is utilized to obtain the value of moisture content. Repeated tests are conducted by introducing additional water, roughly 2% at a time, until the weight of the mold stacked with wet soil decreases. This test procedure is also performed for various soil samples that contain different percentages of sand, lime, and cement. the sample of soil + 10% Sand +5% Lime + 5% Cement, Soil + 15% Sand +5% Lime + 5% Cement, Soil + 20% Sand +5% Lime + 5% Cement respectively

4.2 Specified Gravity Test

After obtaining a 200-gram sample, it is passed through a sieve with a pore size of 4.75 mm and then dried in an oven for 24 hours. Once removed from the oven, the sample is allowed to cool to room temperature for 30 minutes. The specific gravity is then measured using a density bottle, using the procedure outlined in IS 2720 (part II) 1980.

Sr.No	Parameter	Observation
1	Weight of density bottle (W_1 g)	640
2	Weight of density bottle + dry soil (W_2 g)	740
3	Weight of bottle + dry soil + water (W_3 g)	1501
4	Weight of bottle + water (W_4 g)	1483
5	Specific gravity	1.21

4.3 Liquid Limit Test

The 50 gm of soil sample was taken and it was oven dried for 24 hours after 24 hours let cooled down at room temperature for 30 minutes. And it is taken into the cup closer to 10 mm and given the 20 blow in the standard manner.

Sr. No	Parameter	Observation
1	Number of blows	20
2	Container number	I
3	Weight of container	16.62
4	Weight of container + Wet soil	39.12
5	Weight of container + Dry soil	31.22
6	Weight of water	7.90
7	Weight of over dry soil	14.60
8	Water content	54 %

4.4 Plastic Limit Test

In the plastic limit it is the moisture content in the soil were the soil is behave like a plastic.

Sr. No	Parameter	Observation
1	Container number	II
2	Weight of container	20.18
3	Weight of container + Wet soil	38.33
4	Weight of container + Dry soil	33.52
5	Weight of water	4.72
6	Weight of over dry soil	13.34
7	Water content	36 %

4.5 Moisture Content Test

We take a sample of soil weighing 50 grams and place it in an empty container. The container is weighed and then oven dried for 24 hours at a temperature of 110^0. After drying, the container is allowed to cool down to the room temperature.

Sr. No	Parameter	Observation
1	Container number	III
2	Weight of container	29.23
3	Weight of container + Wet soil	62.90
4	Weight of container + Dry soil	59.19
5	Weight of Moisture	3.71
6	Weight of dry soil	29.96
7	Water content	12 %

4.6 California Bearing Ratio Test

In the California bearing ratio we have taken 5 kg sample for each test we conducted 4 test in California bearing ratio (soil, Soil+ 10% sand+ 5% cement+5% lime, Soil+ 15% sand+ 5% cement+5% lime, Soil+ 20% sand+ 5% cement+5% lime) compare them with each other. First we oven dried the soil for 24 hours after 24 hour cooled down the soil in room temperature for 30 minutes then mixed it with desired water then fixed the extension collar to the top the mold and the vase plate to its bottom. After insert the spacer disc over the base and then put a filter paper on the top of the space disc and compact the soil in the soil the we use heavy compaction. We used 5 layer of soil in mold compacted it with 56 blow for each layer then removed the excess soil

then turn the mold upside down and then removed the base plate and the displacer disc. Then weight the mold for determination of bulk density and dry density. Then put the filter paper on the top of the compacted soil and performed the California bearing ratio.

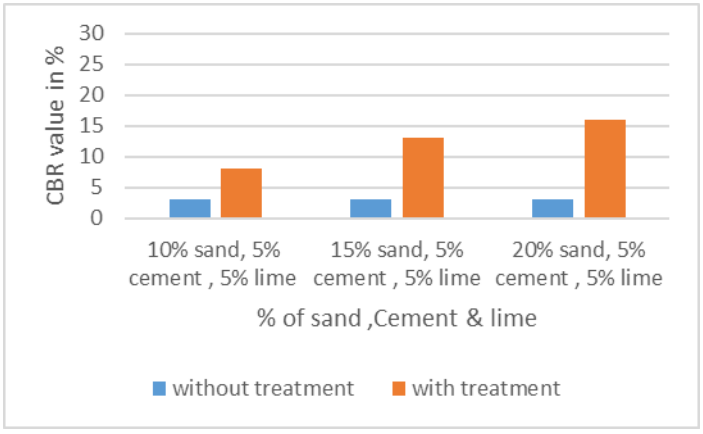

Chart -1: CBR Test

5. RESULT & DISCUSSION

Sr. no	Name of test	Without treatment	10% sand, 5% cement, 5% lime	15% sand, 5% cement, 5% lime	20% sand, 5% cement, 5% lime	Unit
1	Modified proctor test					
	a) Maximum dry density (MDD)	1.65	1.69	1.73	1.75	g/cc
	b) Optimum moisture content (OMC)	17.16	16.25	16.02	15.03	%
2	Specific gravity	1.21	-	-	-	-
3	Moisture content	12.00	-	-	-	%
4	Atterberg limit					
	a) Liquid limit	54.00	-	-	-	%
	b) Plastic limit	36.00	-	-	-	%
	c) Plasticity index	18	-	-	-	%
5	California bearing ratio	3	8	13	16	%

6. CONCLUSIONS

According to the results of the earlier studies, material like cement, sand, and lime can be used to strengthen the stability of black cotton soil. The region of BC soil will be suitable for laying pavements if the density of the soil grows since it supports an increase in CBR value.

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